WARREGO VALLES AND OTHER CANDIDATE SITES OF LOCAL HYDROTHERMAL ACTIVITY WITHIN THE THAUMASIA REGION, MARS.

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Introduction. We have previously demonstrated for the Thaumasia region of Mars that (1) valley formation peaked during the Noachian and declined substantially during the Hesperian and Amazonian Periods and (2) valleys, many of which form networking systems, largely occur near volcanoes, highly faulted terrains, and large impact craters of similar age, thus suggesting hydrothermal activity [1,2]. In Tanaka et al [3], the various hypotheses for valley formation on Mars are presented, and a geologic explanation for valley erosion in the Thaumasia region is given that "best fits" the region's geographic and geologic datasets. That comprehensive GIS-based investigation suggests that hydrothermal and seismic activity were the primary causes of valley formation in the Thaumasia region; the data make widespread precipitation less likely as a major factor in valley formation, except perhaps during the Early Noachian, for which much of the geologic record has been destroyed. Based on the reconstruction of the stratigraphic, tectonic, volcanic, and erosional histories and the close association of valleys in time and space with Noachian to Early Hesperian volcanoes and rift systems and Hesperian to Early Amazonian impact craters >50 km in diameter [3,4], we propose 13 sites of hydrothermal activity within the Thaumasia region (Fig. 1; Table 1); these are the best examples of valleys associated with these geologic features, but there are other less pronounced correlations elsewhere in the region [3,4].

Warrego Valles. The Warrego Valles region is the best example of inferred hydrothermal activity that may have accompanied Noachian and Early Hesperian valley formation in the Thaumasia region (site 4 of Fig. 1 and Table 1). Here, geologic and geographic arguments suggest that an intrusive body at depth resulted in prolonged heating and hydrologic activity to form Warrego Valles by groundwater sapping, as follows: (1) Warrego Valles formed concurrently with Late Noachian/Early Hesperian nearby fault and rift systems and collapse pits and depressions [1], (2) Late Noachian/Early Hesperian faults appear deflected about and absent within the source region of Warrego Valles [4] such as at other proposed sites of intrusive activity on Mars [5], and (3) a center of tectonic activity shown by a concentration of fracture intersections during Late Noachian/Early Hesperian coincides with the topographic high dissected by Warrego Valles [6].

Future Exploration. Proposed sites of volcanic-, intrusive-, tectonic- and impact-related hydrothermal activity may have produced zones of mineral alteration that can be searched for in TES data [7]. These sites may be optimum for future hydrologic-, mineralogic-, and exobiologic-related science investigations.

References: [1] Dohm, J.M., et al. (1997) *LPSC Abs. 28*, 301. [2] Tanaka, K.L., et al. (1997) *Conference on Early Mars*, LPI contribution no. 916, 75. [3] Tanaka, K.L., et al., *this volume (valley erosion abstract).* [4] Dohm, J.M., et al. *(map in review).* [5] Scott, D.H., and Dohm, J.M., (1990) *MEVTV Workshop Abs.*, 39. [6] Anderson, R.C., et al., *this volume (significant centers abstract).* [7] Christensen, P.R., et al., *JGR 97*, 7719.

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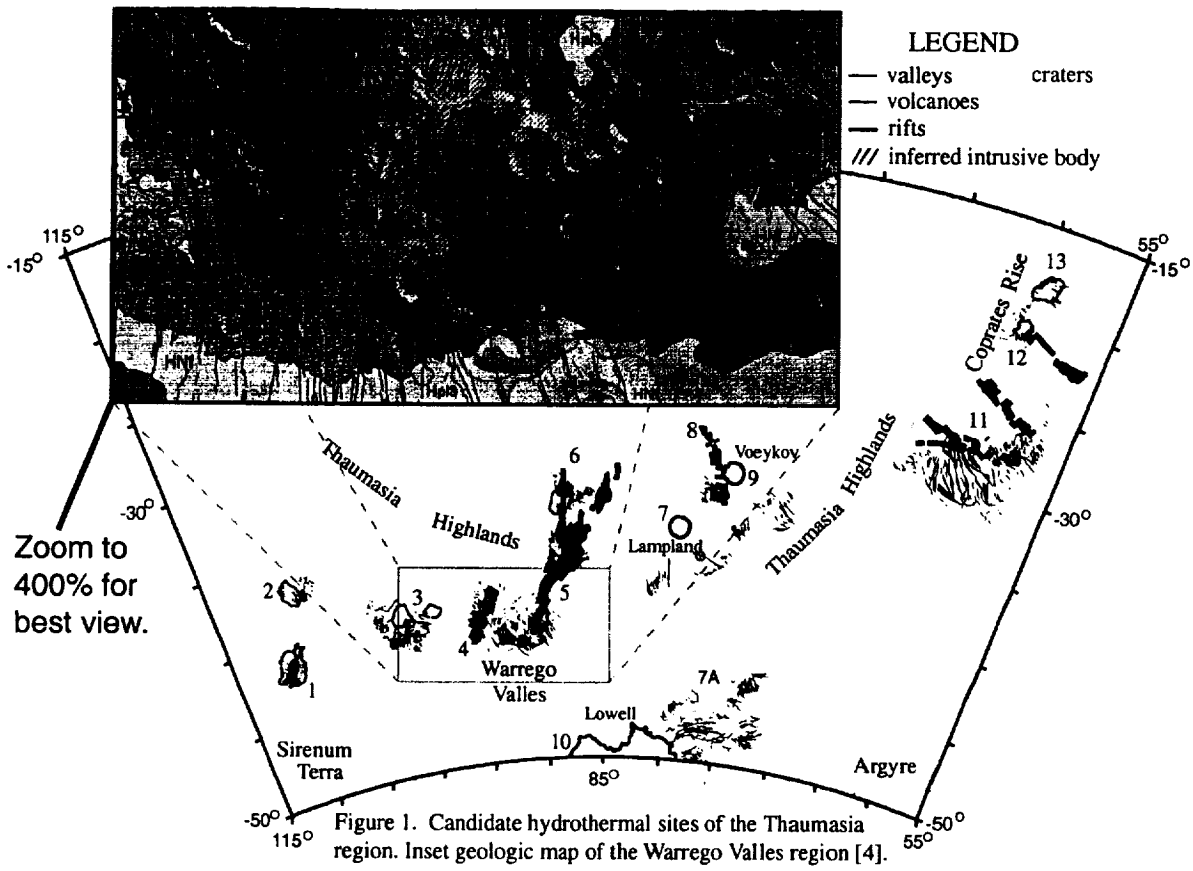

Figure 1. Candidate hydrothermal sites of the Thaumasia region. Inset geologic map of the Warrego Valles region [4].

Table 1. Probable hydrothermal sites of Figure 1.

Sites	Surface Expression	Geologic Activity	Timing	Valley Origin
1	volcano, summit depressions, faults and grabens, rift system, isolated valleys and valley networks	volcanism, faulting, valley formation, Mars quakes, heating, and intrusive activity	Noachian (stage 1)	volcanic- and tectonic-related hydrothermal activity; local precipitation (?)
2	volcano, lava flows, summit depressions, isolated valleys and valley networks, broad ridges and large scarps (possible contractional features), and faults and grabens	volcanism, faulting, Mars quakes, heating, valley formation, and possible intrusive acitivty	Late Noachian/ Early Hesperian (stage 2)	volcanic- and tectonic-related hydrothermal activity; local precipitation (?)
3	volcano, lava flow, faults and grabens, rift system, large scarps, isolated valleys and valley networks	volcanism, faulting, Mars quakes, heating, valley formation, and possible intrusive activity	Late Noachian/ Early Hesperian (stage 2)	volcanic- and tectonic-related hydrothermal activity; local precipitation (?)
4 (Warrego)	large depression, pit crater chains, rift system, faults and grabens, broad ridges and large scarps (possible contractional features), dense concentrations of isolated valleys and valley networks, high topography and deflected faults and grabens near source region	volcanic (?), faulting, Mars quakes, possible heating, valley formation, and possible intrusive activity	Late Noachian/ Early Hesperian (stages 2 and 3)	volcanic- and tectonic-related hydrothermal activity
5	volcano, rift systems, faults and grabens, scarps, isolated valleys and valley networks	volcanic, faulting, Mars quakes, heating, and possible intrusive activity	Late Noachian/Early Hesperian (stage 2)	volcanic- and tectonic-related hydrothermal activity; local precipitation (?)
6	volcano, rift systems, faults and grabens, isolated valleys and valley networks	volcanic, faulting, Mars quakes, heating, and possible intrusive activity	Noachian (stage 1)	volcanic- and tectonic-related hydrothermal activity; local precipitation (?)
7 (Lampland)	impact crater and ejecta blanket, faults and grabens, broad ridges and large scarps, isolated valleys and valley networks, valleys formed along existing structure	impact cratering, and valley formation	Late Noachian/ Early Hesperian (stages 2/3)	impact related hydrothermal activity
8	rift systems, faults and grabens, broad ridges, isolated valleys and valley networks	faulting, Mars quakes, possible heating and and impact cratering	Mainly Noachian (stage 1)	volcanic- and tectonic-related hydrothermal activity; impact-related (?)
9 (Voeykov)	impact crater and ejecta blanket, faults and grabens, broad ridges and large scarps, isolated valleys and valley networks	impact cratering, and valley formation	Late Noachian/ Early Hesperian (stages 2/3)	impact related hydrothermal activity
10 (Lowell)	impact crater and ejecta blanket that buries faults and grabens, and isolated valleys and valley networks	impact cratering, and valley formation	Late Hesperian/ Early Amazonian (stage 4)	impact related hydrothermal activity
11	rift systems, faults and grabens, depressions (near source regions), large scarps and subdued wrinkle ridges, trough networks and isolated troughs, and possible pyroclastic deposit	faulting, trough formation, Mars quakes, possible heating, and possible volcanic and intrusive activity	Late Noachian/ Early Hesperian (stages 2 and 3)	tectonic and possible volcanic hydrothermal activity
12	volcano, summit depression, faults and grabens, rift system, isolated valleys and valley networks	volcanism, faulting, valley formation, Mars quakes, heating, and intrusive activity	Noachian (stage 1)	volcanic- and tectonic-related hydrothermal activity; local precipitation (?)
13	volcano, summit depressions, faults and grabens, and isolated valleys and valley networks	volcanism, faulting, valley formation, Mars quakes, heating, and intrusive activity	Late Noachian/ Early Hesperian (stage 2)	volcanic- and tectonic-related hydrothermal activity; local precipitation (?)